



The impact of Virtual Reality technology in
Portuguese real estate

Diogo Ringler

152118343

Dissertation written under the supervision of Gonçalo Saraiva

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Abstract

Title: The impact of Virtual Reality technology in Portuguese real estate.

Author: Diogo Infante Ossemame Ringler

This research aims to understand and analyze the impact that Virtual Reality can have, and is having in real estate. It aims to study how virtual reality can be impactful to the consumer's buying process, brand relationship, and its effectiveness to the businesses that employ the technology.

Virtual reality is a technology that creates an artificial environment generated with a computer with the goal of simulating a real environment and present it to the user as such. It can be of the immersive or non-immersive type, depending on the additional hardware required, although the real estate companies that use it nowadays opt for the non-immersive type. The use of this technology has become increasingly popular, being common in industries like the gaming industry, and real estate to a lesser extent.

This research gathered data that evidences that consumers are generally positive towards virtual reality, and show a high level of acceptance to including virtual reality in the process of searching for a house to buy, indicating that the technology is ready to become widespread and relevant. Furthermore, the study helps understand that from the business perspective, virtual reality in its current state lacks cost effectiveness to be worthy of widespread implementation in real estate businesses. Nonetheless, the data suggest that the subject matter of this research holds relevance for the consumer and may become important in the near future.

Keywords: Virtual Reality; Real estate; Consumer Behavior; Consumer Buying Process.

Resumo

Título: O impacto da tecnologia de Realidade Virtual no setor imobiliário Português.

Autor: Diogo Infante Ossemame Ringler

O objetivo deste projeto é entender e analisar o impacto que a Realidade Virtual tem e pode ter futuramente no setor imobiliário. O estudo analisa de que forma a Realidade Virtual pode afetar a decisão de compra do consumidor, a sua relação com a marca, e a eficiência da tecnologia para a empresa imobiliária que a implementa.

Realidade Virtual é uma tecnologia que cria um ambiente artificial através de um computador com o objetivo de simular um ambiente real e apresentá-lo ao utilizador como tal. Pode ser do

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tipo imersivo ou não-imersivo, variando de acordo com o tipo de hardware necessário, sendo que o tipo mais utilizado no setor imobiliário atualmente é o não-imersivo. O uso desta tecnologia tem crescido em popularidade, tendo até uso comum na indústria de videojogos e a indústria imobiliária.

O presente estudo recolheu dados que evidenciam uma atitude positiva do consumidor em relação à Realidade Virtual, e um nível alto de aceitação perante a ideia de incluir Realidade Virtual no processo de procura de casas, indicando que a tecnologia está pronta para ter uso mais comum no setor imobiliário, de acordo com o consumidor. Adicionalmente, o presente estudo analisa a perspetiva empresarial da tecnologia, entendendo que para as empresas do setor imobiliário, a Realidade Virtual é pouco eficiente financeiramente, dificultando a sua implementação por parte das agências imobiliárias. Em suma, os dados recolhidos sugerem que o tema do presente estudo é relevante para o setor imobiliário em Portugal e deve ser sujeito a análise futura.

Palavras-chave: Realidade Virtual; Setor Imobiliário; Comportamento do Consumidor; Processo de Compra do Consumidor.

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1. Introduction

Virtual reality is a trending technology that has gained tremendous popularity, mainly for its uses in areas like gaming. Since the technology and its uses have been growing exponentially, increasingly more sectors benefit from the technology (Patel & Sakadasariya, 2018). There are various examples of industries benefitting from VR, like the healthcare industry, teaching and simulators (Yavrucuk & Tarimci, 2011), but there still is a lack of data about the use of VR in the industry that will serve as the focus of this research: real estate.

The real estate sector is a sector that tends to be affected by technological change, as information technologies have consistently played a role in altering how the industry operates (Dixon, 2005). Due to VR being a technology still in its development years and with sporadic implementation, its real impact is still somewhat understudied.

The aim of this research is to analyze the impact and effectiveness that VR can have in the real estate industry. The scope of this analysis will encompass the point of view of the real estate consumer and the advantages VR can bring to them, while simultaneously approaching the business point of view to assess how effective the use of VR is in the industry at this point. This project will look at multiple approaches regarding the subject matter, like understanding if the consumer has any interest or advantage to get from using VR, if the use of such technology helps build a relationship between the business and the consumer, and the extent of the benefits or disadvantages that using such a novel technology brings to a business in the real estate industry.

1.1 Relevance

As the goal of this study is to determine the impact that VR technology can have in various facets of the Portuguese real estate industry, it is important to understand the technology at hand, if it has been implemented already and how is it being implemented. It is also important to look at the subject from the business side of the conversation and to understand what type of real estate agencies implement this technology, their reasoning behind it and the implications of doing so.

Virtual Reality is an artificial environment created with computer software and presented in a manner that leads the user to accept it as a real environment. In the real estate sector, this technology is often times employed with the use of the Gyroscope software to scan the apartment, a VR headset, Google VR SDK to build the content and the Unity editor (Sonje, et

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al.,2018). There have been studies suggesting that customers who used VR technology to walk around a property virtually, modify aspects of the house and observe various rooms felt like they were in a real house and wanted to buy the house afterwards (Ozacar, et al., 2017).

A customer may also be influenced by the use of immersive or non-immersive VR. Non-immersive VR refers to a VR experience where the user interacts with a virtual world displayed in a computer using a screen, mouse, touchpad and/or handheld control. In immersive VR the user uses a head-mounted display to move through the 3D environment. It has been shown that the immersive VR experience enhanced satisfaction and purchasing interest of the customer (Talukdar and Yu, 2018).

Having looked at existing literature, it is apparent that even though the technology has had some kind of implementation up until now, there are still not many concrete evidences about the effect and practical change that it brings to the table. Furthermore, it is known that the technology has been used in some Portuguese real-estate agencies, but in this case there is even fewer literature to corroborate its effects. As such, this research will mainly aim to complete the existing cases with information that attest to the usefulness of this new technology in this specific sector. In summary, the study will aim to find and clarify the effectiveness in cost, time and interest of the technology for the real estate agencies and the possible effects of these on potential customers.

1.2 Dissertation Framework

This research is structured as follows:

1. Introduction

In this section, the purpose is to introduce the topic of the research by presenting the characteristics of Virtual Reality technology, the real estate sector, and the intersection between both themes that this research aims to study.

2. Literature Review

To understand the impact of Virtual Reality in real estate, it is essential to first analyze how the technology is being employed, how the real estate sector reacts to technological innovation, and the behavior theories behind the consumer response in this sector. With this information, the basis for the following research will be established and solidified.

3. Methodology

Due to the goal of understanding the impact of Virtual Reality in real estate from the perspective of the consumer and the business, two different data gathering methods were

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used. This section explains the methodological approach taken by this research, and the two methods employed: survey and interview. Furthermore, this section also describes all the steps used in the data gathering procedure.

4. Results and Discussion

Finally, the last section summarizes the data acquired through Qualtrics and analyzed with SPSS, in order to validate the proposed hypothesis. The same is done with the interviews, although analyzed qualitatively and not quantitatively. Following this, a brief discussion of the results and their implications is presented, before concluding the research and suggesting its limitations and future developments.

2. Literature Review

In this part, an overview of the existing literature with themes that are relevant for this research will be presented, such as an explanation of the Virtual Reality technology, customer reaction and the impact that this technology currently has in the industry, as well as the impact it can still achieve in the future.

2.1. Virtual Reality and its uses

2.1.1. Definition:

As the focus of this research is Virtual Reality technology and its relevancy to the business and managerial perspective, and taking into account that this technology is something relatively new in its widespread implementation, this chapter aims to describe it in simple terms. It should be noted that for this research, the technical aspects of VR are not the most relevant, and are secondary to the application of the technology.

As stated before, Virtual Reality is an artificial environment created with computer software and presented in a manner that leads the user to accept it as a real environment. Its main goal is to allow the user to see and interact with a 3D world, in a manner that would not be possible with simple 3D environments seen on computers. It has varying degrees of immersion, each degree associated with the type of industry it is being employed in. Ivan Sutherland first touched upon this concept in 1965, in an article named “The ultimate Display”, in which he proposed the technology in a very rudimentary stage. In current days, VR is used in industries like Entertainment, Medicine, Engineering, and most important, real estate (Alqahtani et al., 2017).

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According to Li (2016), the virtual environment is created with the use of software and hardware, and then experienced by use of the body, with the aid of information technology and the appropriate hardware equipment that enables the user to experience the environment just like the real environment. The main goal of this technology is to provide the user with realistic sound and image that stimulates an imaginary setting, to best simulate a physical environment. Its uses are, for example, for designers who wish to fully decorate their room and have it done virtually before doing it physically, changing the position of the decoration according to their own taste until their idea is met. This way, said designer can save time and be more effective. In real estate, the use of the technology is mainly to give the experience of a complete and in-depth house-tour without the need to be physically present in the house.

2.1.2. Applications:

In this section, some examples of successful VR appliances in current days are displayed. VR has been widely used in several areas, and exemplifying some of them may help understanding the potential of the technology in real estate.

In recent times, virtual worlds have been important in teaching and training, as an alternative to the traditional teaching method. This new era of learning allows students and trainees to learn task in their own way, which is a factor that can be transported to other areas like real estate (Romero, et al., 2010). Besides the musical teaching, this technology has been successfully applied in fields like Education, Medicine and Construction (Campbell, et al.,2020). Virtual Reality has been used by well-known brands like Coca-Cola and Ikea for advertising and marketing campaigns due to its ability to help build brand awareness and stay in the mind of consumers when using such an unusual and innovative form of advertising, either by ways of pop-up locations where the consumer experiences the VR advert in a place of brand's choice, or even by ways of a YouTube video that can be visualized at home with a smartphone enabled VR headset (Gaulquier, et al., 2018). This research aims to discover if the use of VR in real estate is as effective as in the previous examples.

After introducing the potential of the technology in other areas, it is more relevant to specify its uses in the area that this study will focus on: real estate. In recent years, there has been a surge of use-cases of Virtual Reality in the real estate business. One such case is Sotheby's, and according to www.sothebysrealty.com, a virtual tour option is given in their website, which is constituted by a smartphone application and a smartphone VR headset. For the business side, Sotheby's claims that a virtual tour adds more content and layers when compared to the typical photo display that most real estate agencies offer. For the consumer, this option is sure to

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optimize the time expended between visits to various homes if they were made physically. Furthermore, this method effectively eliminates phases and streamlines the overall choosing process, which tends to have a more positive effect on customers. What this means in practice is that a customer can visit multiple houses virtually within a day, and choose the ones they like the most to visit in person. Typically, visiting multiple houses takes several days and scheduling flexibility, which VR addresses with the application of non-present visits (Pleyers & Poncin, 2020). The main advantage would be that traveling a property with VR and without leaving a chair, the amount of detail harnessed would be close to the detail obtained by a visit in person, thus saving time and money while still obtaining the same level of success.

The uses for VR in real estate are not limited to non-presential visits of existing homes. According to Kun & Zhong (2009), with VR, companies or individuals can see the completed product of an under-construction property months or years before completion.

2.1.3. Types of VR systems:

This research will be geared towards the VR system, specifically the non-immersive type and its characteristics that will be further developed in this section.

As described by Bamodu & Ye(2013), there are 3 types of VR system: non-immersive, immersive and semi-immersive. This distinction is based on the immersion and the components utilized in the system.

The non-immersive type of VR is also known as Desktop VR is the least expensive but also the least immersive one, due to the relative simplicity of its components. Using this system, the user can interact with 3D environments through a monitor display and glasses.

The most expensive of the three types of VR is the immersive one, mainly due to its components like a Head-Mounted Display (HMD), tracking devices and other highly immersive equipment.

The third type of VR system is called hybrid or semi-immersive, more commonly known as augmented reality. Its goal is to provide high levels of immersion while still being easy as simple as Desktop VR. This system is employed in, for example, driving simulators.

As referenced before, in this research the non-immersive VR system will be the one in focus because most real estate firms that use VR use this type of immersion, as seen with Sotheby's, and later in this research, with Zome.

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2.1.4. Components:

According to Bamodu & Ye (2013), a VR system is composed of the hardware and the software. The hardware can include a computer and VR engine, and the software mainly include the application and database as its components.

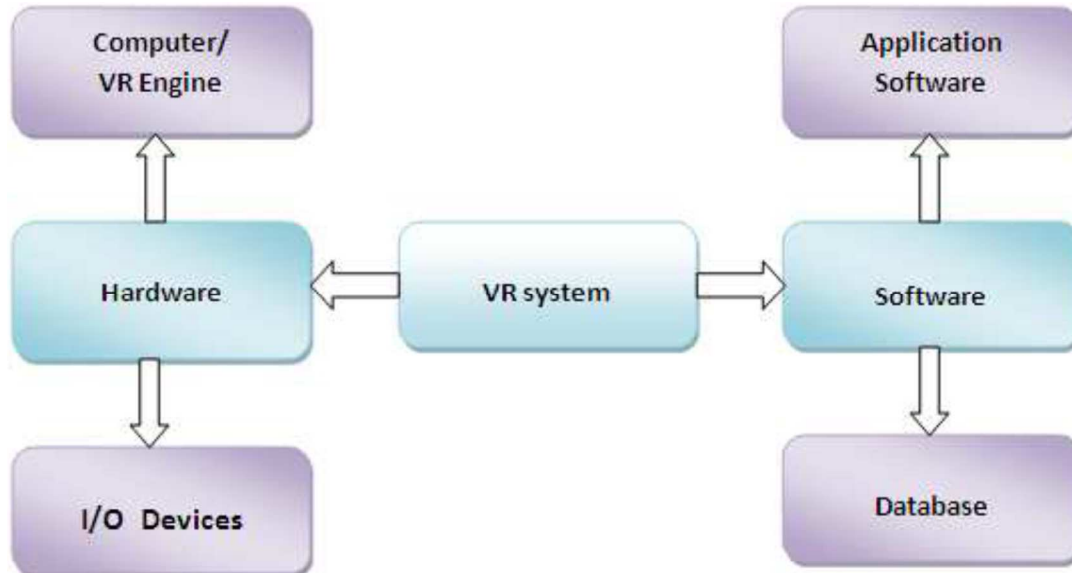


Figure 1- Components of Virtual Reality Systems (Bamodu & Yen,2013)

Hardware:

Input devices and output devices, as shown in Figure 2 compose the system hardware in itself



Figure 2- Virtual Reality System Hardware (Bamodu & Yen)

The input devices are used to interact with the virtual world. Its main goal is to transmit the actions of the user to the system. These can come in the form of tracking devices, bio-controllers and voice devices.

The VR engine, which is usually selected according to the application requirements, does some of the most important and time-consuming tasks like graphic display, image generation, object rendering, mapping, texturing and simulating. This component is dependent on the computer's processing power, as the computer will have to render a certain amount of graphics and sounds within a short time-frame to be efficient.

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Lastly, the output devices have the purpose of passing the feedback from the VR engine to the user, thus stimulating their senses. These output devices can be classified based on the senses as graphic, audio and haptic, which are the most used in VR systems.

Regarding the software part of a VR system, the tools used to design, develop and maintain the virtual environment can be classified as modelling tools or development tools.

2.1.5. Challenges and limitations of Virtual Reality:

As with any new technology, Virtual Reality is not without its challenges and limitations. The literature suggests that more often than not, these challenges are dependent on which industry the technology is being implemented, although this section will touch on the more general limitations of the technology itself.

As stated by Alqhatani et al. (2017), the Virtual Reality technology still has the financial obstacle, as the money requirement varies depending on the type of immersion wanted. In this case, the money invested for implementing the technology is directly correlated to the level of immersion that is desired. For example, in the flying simulators area, the implementation of this technology had a cost of about 15,000 \$ (Yavrucuk & Tarimci, 2011). Even though this case deviates from the real estate emphasis given in this research, it is just an example of how high-priced the technology can be overall.

Another one of the big limitations of the technology is related to the maturity of it, as its widespread adoption is a recent trend with just over a decade of general use. The young nature of VR dictates that limitations like low-battery life span of VR headsets and low image resolution (Delgado et al.,2020). At this stage of maturity of the technology, the need of addressing the specific requirements of each professional sector still exists, as most existing VR devices were developed for the entertainment sector and the lack of devices geared specifically towards the real estate, construction or engineering sectors is noticeable and poses an interesting development challenge for the future of the technology.

2.2. Real Estate Industry

2.2.1. Overview of the real estate sector:

Having approached the literature from the technological perspective before, this section will focus on the industry perspective. In this topic, the points of importance are the real estate industry and its characteristics, with the goal of illustrating how VR is useful in the industry and understand if the technology addresses the particular challenges of the industry.

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As the services industry grows at an unprecedented pace, the need for new technologies that support this growth expands, especially in highly competitive sectors such as retail and wholesale, hotels and restaurants and real estate (Stevens & Zhu, 2010). The necessity of innovation is result of how little the real estate industry has changed in the last decades, coupled with the fact that new technology pushes the boundaries of what firms can do to differentiate themselves and offer superior service (Brohman et al., 2009) is part of the reasoning behind the choice of this industry and technology in particular.

In current day, one of the biggest challenges that the real estate industry faces is related to the transaction delays that could be improved with the adoption of technologies geared towards it. As the industry is plagued by bureaucratic challenges in registration processes that could be solved by implementing technologies like Blockchain and VR, the industry itself does not appear to be accepting of these new methods. Regulatory and social barriers seem to have the most weight when considering the willingness of investing into new technologies, when it comes to real estate. Nevertheless, it is important to note that within these technologies that don't have as widespread use as they could have, VR is one of the easiest to willingly accept in the industry. This is mainly due to the fact that VR is used for a specific element of the transaction process and not for the whole transaction in itself (Saul et al., 2020)

From a managerial perspective, the need to differentiate one's own product is present in current days, given how homogeneous the real estate industry is. With that in mind, the most effective way to enhance the buying experience and therefore the consumer's own experience is through uncommon products. It is then appropriate to conclude that the advent of new technologies and their rising popularity is a natural consequence of the evolution of the real estate market (Pleyers & Poncin, 2020)

To illustrate further how Virtual Reality can help in this specific sector, a brief description of the sector's components is presented. The roles within the real estate industry include brokerage, property management, valuation and research, funds management, development and construction planning (Kummerow & Lun, 2005). Traditionally the seller of a property resorts to an agent (broker) to aide them in a sale and provide expertise, but this method has changed slightly due to information technology, as most properties nowadays are listed in websites and can be found by a buyer without the need for an agent (Stevens and Zhu, 2010). In addition, the real estate industry has always been inefficient in terms of cost (Kummerow & Lun, 2005),

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which is a particular inefficiency that this research aims to connect with VR technology to assess if it can address it directly.

2.3. Consumer Behavior:

As part of this research is gathering the consumer's position and perspective on the use of Virtual Reality on the home buying experience, it is relevant to mention some consumer behavior characteristics that may pose some importance in the subject matter.

In a study with the purpose of evaluating subjective real estate preferences, Llinares & Page (2011) use Kano's model to assess the contribution of different features to perceived quality. The model assumes that there is not a linear relationship between fulfillment of a need and experienced satisfaction of a consumer. Kano's model highlights 3 different types of requirements according to the type of response they induce in the consumer: basic, exciter and linear attributes. Basic needs cause dissatisfaction if not present, but do not cause satisfaction if present. Exciter needs increase customer satisfaction if present but do not cause dissatisfaction if not present. Lastly, linear needs cause satisfaction if well performed and dissatisfaction if they are not well performed. These attributes were then coupled with the Kansei Engineering theory to discover how emotional factors affect the property purchasing decision, creating an approach that inserts consumer purchase decision as a key factor in product development and simultaneously makes it possible to quantify each attributes' weight in the purchasing decision. The study concluded that the attributes that mostly influence purchasing decision are the linear attributes or needs, followed by the exciter attributes, and finally the basic attributes.

Moreover, it is known that consumer behavior in in part affected by cognition perceptions such as visual information, as visual attention induces positive response towards a brand (Guerreiro et al., 2015), which can be relevant for this research in particular due to the visual nature of the technology at hand.

When it comes to the behavioral patterns of consumers in the real estate industry, literature points to the effect of technologies and an increase in the need of compelling experiences to incentivize customers and meet their demands (Sipe & Testa, 2018). Given the high competitiveness of this industry in most countries, the differentiation factor is relied upon to attract more clients. The decision of using an uncommon technology is usually a good and efficient strategy in improving the attitude of the consumer towards the brand, and consequently enhancing the intention to purchase. Consumers in this industry are increasingly demanding in

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regards to the type and quality of experience they get, in order to be attracted to one firm over the other. For instance, clients tend to prefer VR presentations of any type over a typical photo presentation. Moreover, in these types of experience, consumers usually respond better to the non-immersive type of VR system, due to it being easier to handle with the absence of a head-mounted display (Pleyers & Poncin, 2020).

2.3.1 Customer Relationship Management

Since this research aims to understand the benefits of VR for both the customer and business side, it is relevant to briefly present a theory that somewhat connects and explains the relationship between both parties.

As said before, customers tend to gravitate towards the companies that offer more personal and uncommon experiences that fit their own personal tastes. To satisfy these needs, companies have to constantly try to add value to their services, so they can keep being appealing to the demanding consumer (Chen & Popovich, 2003)

Thus, the main goal of the Customer Relationship Management theory is to find ways to retain the customer's loyalty and preference, and consequentially increase profits (Burnett, 2001). The way to achieve this goal may differ, but in this particular case can be achieved with technology. For instance, the company can use virtual data collection methods to store and analyze data that will allow for customer patterns to be recognized and the necessities of the customer being answered in an easier manner, in the future (Butler,2000). Social Customer Relationship Management is an example of this, as it is defined as the strategy of engaging customers through social media with the goal of building trust and brand loyalty (Woodcock et al., 2011). For this research, VR will play a similar role as social media had in the study by Woodcock et al (2011), which is to understand if the technology plays a role in generating customer engagement and positive opinions about the company using it. If that is the case, the company is probable to benefit from a preferred behavior from its customers (Dewnarian et al.,2019)

2.3.2 The Technology Acceptance Model

The Technology Acceptance Model (TAM) is a relevant theory to help characterize certain behavioral patterns when it comes to customer's interaction with new technologies, especially web-related technologies. This theory, created in 1986, proposes that when accepting a new information technology an individual bases their decision on the Perceived Usefulness and Perceived Ease of Use of said technology (Lee et al., 2003). According to the theory, the Perceived Usefulness and Ease of Use naturally lead to discovering the attitude toward using the technology from the perspective of the individual, then to a behavioral intention to use the

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technology and finally to the actual use of the technology, thus realizing its acceptance (AL-Emran et al., 2018). Overall, this theory brings a standardization of factors that connects emerging technologies and techniques with past research to predict how widespread they can become. This research will take influence from this model and aim to be aided by it in its conclusion.

For instance, this model can be useful in contextualizing the willingness to adopt VR between each gender (Folkinshteyn & Lennon, 2016). In some cases, TAM indicates that the acceptance of a given technology is related to its perceived usefulness and not by its perceived ease of use. Despite this dichotomy, there are cases where the male gender gives more value to the ease of use when determining acceptance, meanwhile usefulness and enjoyment are the deciding factors for women (Kim et al., 2016). Other relevant factors in this topic are the satisfaction security and quality provided by the technology that is being discussed. These three factors are highly relevant to consumers when it comes to embracing a new technology, and are also excellent predictors of how easily a technology will be accepted by the consumer if implemented (Taherdoost, 2018).

In the real estate industry, this theory is relevant to understand the reaction to changes in the buying process. As referenced before, it is understood that customers in this industry look for a differentiating and compelling factor when choosing between firms, and the most frequent differentiating factor nowadays is the technology used (Sipe & Testa, 2018). As such, the consumers in this industry are inherently more accepting of a technology like Virtual Reality, given that they perceive that its goal is to add satisfaction and quality to their experience (Pleyers & Poncin, 2020).

On the managerial perspective, the adoption of this technology may have some barriers. As it stands, firms still view VR and AR technologies as expensive and immature. Factors like the cost of hardware and training, data privacy issues and high processing requirements are limiting to the acceptance process and often negate driving factors such as the reduced cost of project delivery that the technology may bring (Delgado et al., 2020)

3. Methodology

In this section, the proposed methodology to achieve the goals set for this thesis will be presented.

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This research will employ two primary ways of data gathering: an interview dedicated to real-estate workers and experts, and an online survey geared towards the consumer. These data collecting procedures will aim to answer the following research questions:

- 1- Is VR an appealing alternative for the real estate consumer’s buying process?**
- 2- What is the efficiency impact of using Virtual Reality technology in the real estate industry?**

To answer the first research question, interviews were conducted to 2 experts who are workers in the Portuguese real-estate industry. To estimate the impact of VR in this sector, a qualitative approach was used on the interviews, always having in mind the data gathered from the literature review about the characteristics of VR and the efficiency of this technology compared to other methods. In this regard, the primary data was collected with the use of semi-structured interviews in which the 2 real estate professionals referenced earlier had some freedom in their answers, so that they could cover relevant information that was not present in the script. Ultimately, the interviews answered the first research question and helped estimate the impact of the technology in the sector at this point of its implementation.

3.1. Interviews:

As seen previously with examples in other sectors, the implementation of VR technology leads to better efficiency in time consumption and cost wise. However, since most of the literature on the topic of the technology deals with its use in industries other than the real estate industry, which is the main focus of this research, the interview’s questions were aimed at assessing the industry worker’s opinion on the technology, its current implementation, future use and specificities related to the industry that set it apart in regards to its approach to this technology. As such, the following was requested in order to gather the necessary information:

- Current advantages and disadvantages of using VR technology in comparison to the traditional home touring method
- Current implementation challenges
- Implementation costs
- Savings or increased profits brought by implementing VR technology

3.2. Survey:

The second research question was answered using both primary and secondary data, as primary data was collected in a quantitative manner with the online survey, but in turn, the secondary

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data made it possible to develop the hypothesis to be studied. The secondary data, identified in the previews chapter, was essential to develop a model aided by all the information gathered on VR technology and its characteristics and consumer behavior that helped formulate the hypothesis for this research and the questions that constituted the online survey.

After this, the hypothesis were formulated and presented and the survey is developed to be deployed online.

Finally, the data collected from the survey was studied and analyzed so as to gather results from it.

To assess if Virtual Reality an appealing alternative for the consumer’s buying process, some specific aspects like consumer reaction to the convenience of VR and reaction to interaction with the virtual world presented in the VR system were studied.

3.2.1. The Model:

To develop the proposed methodology in order to answer the second research question, the first step taken was to create a model based on the literature review section of this research. The key concepts from that section that influenced the model were the advantages and disadvantages of VR on the customer’s perspective (also referred as Customer Relationship Management), main characteristics of Virtual Reality and consumer behavior. This information lead to the hypotheses that in turn lead to the questions posed in the survey. Each of these 3 concepts has a designated purpose for gathering data.

The Customer Relationship Management aims to understand if the technology and the way it is employed is a differentiating factor and if it has an effect on the view that the customer has on the company using it. In addition, Customer Relationship Management also aims to assess the customers’ willingness to integrate VR in their buying process.

Following that, the main characteristics of VR will aim to assess if customers are familiarized with Virtual Reality and what they attribute value to in the use of the technology, ultimately leading to an understanding about the value the technology has to the consumer.

Lastly, the consumer behavior concept will lead to an understanding of the interest and reactions the consumer goes through during the buying process using VR and how the technology affects their perception of the process.

The following step is to formulate hypothesis, and these hypotheses are either confirmed or denied by the survey’s answers.

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3.3 Hypothesis

As the purpose of this section of the research is to assess if Virtual Reality is appealing and useful for consumers, the hypotheses formulated are directed towards answering this question.

In order to ensure this task, it is taken into account how VR technology is a novel venture and how this novelty factor affects the consumer’s opinion. Following that, an analysis is done on the effects of the interaction between the consumer and the technology, specifically how it affects the consumer’s interest on the technology and willingness to use it in their buying process. This is followed by a look at the presentation of the technology to the consumer, given that it is relevant to understand the commodity, portability, interactivity and mobility characteristics and if these are presented in a way that is easy and convenient for the consumer as these factors can have an impact of the consumer’s interest in the technology and its applications. It is equally relevant to analyze the industry’s approach to the consumer, as in what kind of marketing and campaigns can appeal to the consumer and what does the consumer value the most in the VR sphere. The final aspect to take into account is the interaction between the consumer and the companies that employ this technology, and how can this ensure that a connection between both parts is maintained, in line with the CRM section seen previously.

Thus, and having the previous paragraph in account, the hypotheses are as following:

Hypothesis 1: The novelty and innovation aspect of VR triggers the consumer’s attention.

Hypothesis 2: The consumer responds favorably to the interactivity of VR.

Hypothesis 3: The use of VR is more convenient and comfortable for the consumer.

Hypothesis 4: The consumer creates a connection with the company resulting of the interactivity and experience from the use of VR.

By analyzing these hypotheses with the answers from the survey, the goal of answering the second research question will be reached and it will be known if Virtual Reality is an appealing alternative to the consumer’s buying process.

The survey is available in the appendix.

3.4 Survey Methodology

The main goal of this survey is to understand the utility of Virtual Reality for consumers and their buying process, specifically real estate consumers. To reach this information, a test version

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of the survey was employed at first, to validate the survey. After this, the quantitative approach was employed, in the form of the online survey directed towards a larger group of people.

The goal of the test survey was to understand the consumer and their familiarity with VR technology, in a way that the consumer gave feedback about the accessibility and relevancy of the questions presented in the survey. This was done with the goal of understanding the actual relevancy of the survey questions to the research questions.

3.4.1. Test Survey

The test version of the survey is composed by the questions that were initially developed, and dependent on respondent feedback. It was distributed via e-mail, and its main goal was to assess the perception of the respondents and to understand if they viewed the questions in the way that was originally intended or if adjustments were needed.

3.4.2. Test Survey Sample

Due to the experimental nature of the test survey, the sample size was much reduced. A total number of 5 people answered the test survey after opening a link sent by e-mail. Their ages were between 21 and 26, with 3 males and 2 females.

3.4.3. The Survey

The survey is web-based and it was distributed through social media, specifically Facebook and Instagram.

A six point Likert scale was used, with the goal of avoiding neutral answers and garnering either positive or negative answers, even from indifferent respondents. The option to use a six-point Likert scale in place of a four-point variant was supported by evidence that shows the increased reliability of a six-point scale, as this is the most valid option in discriminating between answers, as to better understand the feelings of the respondents. In most cases, a shorter scale limits the validity and full extent of the answers, thus the six-point scale was the most sensible option (Preston & Colman, 2000).

Certain sections of the survey contained were crafted to build a tendency on the respondent, in the form of conditions in questions. This way, only respondents who had matched a previous condition could answer a specific subsequent question. In a different type of questions that required the respondent to rank a set of feelings, these feelings where often randomized and not always presented in the same order, to avoid bias by having positive feelings first and negative feelings last.

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3.4.4. Survey Sample

As stated before, the survey was distributed online via social media, with no restrictions. This method comes with the limitation of the survey only being available to people with an internet connection.

The survey was answered by 229 individuals based in Portugal, but in total it was exposed to 282. The difference is accounting for individuals who opened the survey but did not reach a level of completion that allowed their responses to be counted, mostly dropping it after the first three answers. Demographically, around 59% of the 229 respondents were aged between 18 and 24, approximately 37% (36.68%) were in ages between 25 and 34, and less than 4% comprise the age gaps between 35 and 54. Given that in some countries the age in which an individual buys their first house is between 18 and 35 (Abdullah et al.,2012), this may warrant some significance to the sample. Regarding the gender of the respondents, around 62% were male (62.45%) and 38% were female (37.55%, to be precise).

3.4.5 Survey Results

Hypothesis 1- The novelty and innovation aspect of VR triggers the consumer’s attention.

Questions 6, 7 and 10 were directly related with Hypothesis 1.

Question 6- Have you ever heard about Virtual Reality technology?

The results of this question show that an overwhelming majority of the respondents had knowledge of the technology, as 95% answered positively, as opposed to the 5% who had never heard of the technology.

Question 7- Have you ever used Virtual Reality?

In this question the results were much more balanced, as only 55% of the 229 respondents had used Virtual Reality of any type, and 45% never used it (Chart 2). With these two questions, we can understand that the technology is known but still not commonly used.

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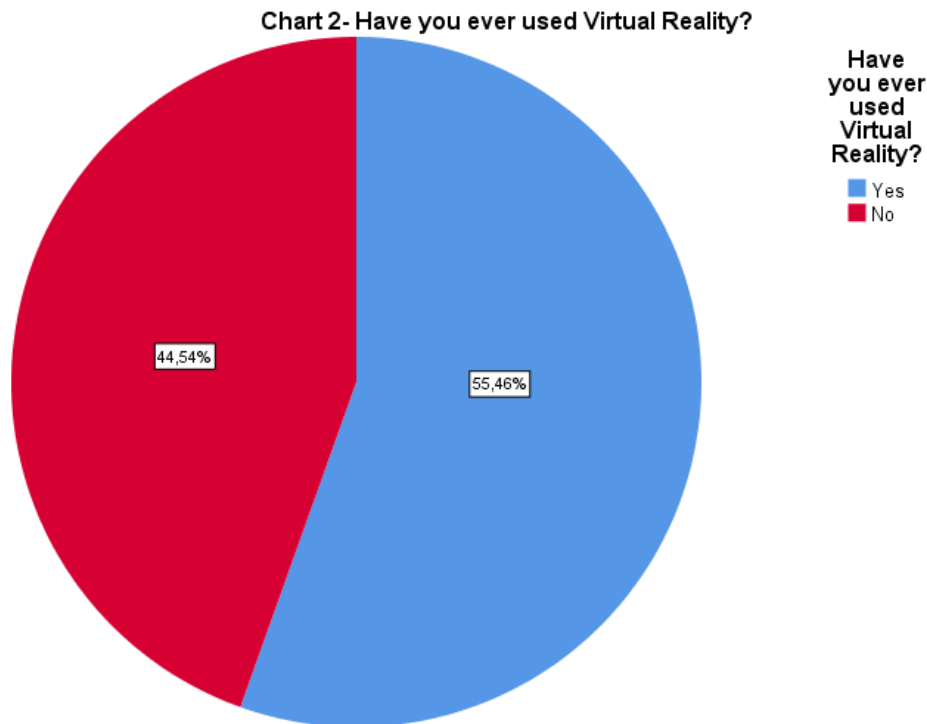


Chart 1- Have you ever used Virtual Reality?

Question 10- Please classify the following statement on a scale from 1 (strongly disagree) to 6 (strongly agree): With the popularization of this technology, the innovation and novelty of it makes me want to learn about it and use it.

Most respondents seem to have favorable views in relation to this affirmation, as 48% agreed with it, and 8,3% strongly agreed, meaning that most of the respondents agree with the statement at some level (88,6% of the answers were positive choices), and the mean of the answers situating at 4,48, which corresponds to “Somewhat agree”. This indicates that a big part of the inquired agree with the proposed importance of the novelty factor of the technology.

Overall, the questions analyzed seem to indicate a favorable view and recognized importance of the novelty factor from the customer’s perspective.

Hypothesis 2- The consumer responds favorably to the interactivity of VR.

Questions 9, 11, 12 and 13 related to Hypothesis 2

Question 9- If you have previously tried Virtual Reality, please indicate on a scale from 1 to 6 what was the degree of satisfaction obtained from your experience. If not, ignore this question:

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Since this question was dependent on if the respondent had previously used VR or not, only 128 individuals answered. Nonetheless, the answers were still satisfying in general, with 118 respondents answering to some degree of satisfaction. In fact, 46% of the 128 individuals who qualified for this answer chose “Satisfied”, and 31% answered “Somewhat satisfied”. Overall, this question indicates that the current state of Virtual Reality technology in general is at least satisfying to some degree.

Question 11- Indicate the degree of difficulty which you associate with using this technology, on a scale of 1 (Very hard) to 6 (Very easy):

The answers to this question indicate that the majority of the 229 respondents do not view Virtual Reality as a difficult technology to handle, as the mean of the answers is 4,19, representing that, in average, the respondents think that the technology is “Slightly easy” to use. Furthermore, 170 of the 229 respondents (amounting to 74%) placed their answers in one of the categories that classify the technology to have an easier degree of use.

The answers to this question clearly point to the general opinion that VR is an accessible technology to the public in terms of uses, and the perception that it is user-friendly.

Question 12- On a scale from 1 (strongly disagree) to 6 (strongly agree), classify the interaction of making a Virtual Reality tour in a house before buying it: Convenient; Attractive; Informative; Fun; Insignificant.

From this question, the results show another very positive indicator that VR is enticing to the buying process, agreeing that using the technology in the real estate context can be convenient and fun. In fact, it is significant to note that most of the respondents believe the technology to be significant in the context of the process of buying a house, as 80% of the 229 respondents do not believe it to be an insignificant exercise.

Observing the other factors, an overwhelming majority of the respondents agreed that doing a virtual tour before buying a house would be convenient, as 206 of the 229 respondents answered positively in this parameter, which amounts to 90%.

Similarly, 84% of the respondents find that a virtual tour would be an attractive experience, including 81 individuals who agree and 29 who strongly agree with the sentiment. In fact, only one respondent strongly disagreed that it would be an attractive experience.

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The favorable trend continues with the informative factor, even though two individuals strongly disagreed that doing a virtual tour before buying a house would be informative. Nevertheless, 81% of the respondents agree in some form about the informative characteristic of using the technology in this context.

The experience can also be considered fun, according to the answers of 200 of the 229 respondents. More than half of the respondents (59%) either agree or strongly agree that the interaction with VR would be fun.

After analyzing each factor of this question, it becomes clear that VR in the context of real estate elicits positive feelings and overall impact on the consumers. As stated before, most of the respondents believe that using Virtual Reality in house-hunting could be convenient, fun, attractive, informative and certainly a significant experience.

Thus, the second hypothesis is confirmed, as the consumer reacts favorably to the interactive factor of VR.

Question 13- After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting? Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree): Uninteresting; Unrealistic; Useful; Fun; Appealing; Difficult to use.

After getting exposed briefly from the real-life case of Sotheby’s and how the company use VR in their business, the answers to this question reveal that the respondents are indeed open and interested in the technology, even finding it useful, appealing and fun.

Firstly, 76% of the 229 respondents find the technology interesting to use by answering in disagreement with the uninteresting label, thus demonstrating that, at least in this sample, VR is something of interest when going through the process of looking for a house. Only 9 individuals strongly agreed that the technology was uninteresting in this regard.

Following that, 73% of the respondents disagree that the use of VR in real estate to do virtual tours is unrealistic. Although in this case it is noteworthy to show that 45 individuals somewhat agreed that it is an unrealistic technology to use in this regard, and this represents almost 20% of the sample. This may evidence that the technology is perhaps not widely known as a real estate tool, due to its lack of use in the country.

Despite that, a large majority of the respondents agree that VR would be an useful tool in house hunting, with 45% agreeing and 38% somewhat agreeing, opposite to only one respondent

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strongly disagreeing with the usefulness of the technology in this regard. Overall, 92% of the respondents agree to some level that VR would indeed be a useful tool in real estate, in their perspective.

Similar to the factor in the previous question, respondents maintain the opinion that it would be a fun experience to use VR, with 92% of the respondents agreeing on this regard, with an even higher percentage than the previous question (91,7% vs 87,3%), although the indicators seem to point to the technology being fun to interact with in either question.

When answering about the appealing factor of using VR while searching for a house, only 11% disagreed with this notion. Effectively, 90% of the respondents find VR to be an appealing alternative in real estate, with an average answer of 4,48, which represent “somewhat agree”.

Lastly, regarding the perception of difficulty associated with the technology in this context, 72% of the respondents disagree that it is difficult to use. Despite this, 52 (23%) individuals somewhat agree that it is a difficult technology to use, and the average answer is 2,98, which places very closely to the “somewhat agree” category.

Overall, data from this question suggests that the respondents respond positively to the possible interaction with VR in searching for a house, although there appear to be some caveats about the realistic and difficulty factors of VR from the respondents, evidenced by the relatively sizeable portion that answered in agreement with those specific parameters.

Hypothesis 3- The use of VR is more convenient and comfortable for the consumer.

For this hypothesis, the relevant questions are 11, 12, 15 and 16

Regarding the convenience and level of comfort that VR provides to the consumer, two questions from the survey overlap with this hypothesis and the previous. As such, for these questions, only a brief explanation will be provided.

Question 11- Indicate the degree of difficulty which you associate with using this technology, on a scale of 1 (Very hard) to 6 (Very easy):

For question 11, that analyzes the level of difficulty associated with the technology, it was already shown that 74% of the respondents believe the technology to be easy to use. This perceived ease of use can be associated with convenience.

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Question 12- On a scale from 1 (strongly disagree) to 6 (strongly agree), classify the interaction of making a Virtual Reality tour in a house before buying it: Convenient; Attractive; Informative; Fun; Insignificant.

Similarly, question 12 also overlaps, but is much more objective, as it directly asks about the convenience factor. For this question, it is relevant to state that exactly 90% of the respondents agreed that it would be a convenient experience, once again indicating that this hypothesis is valid and confirmed.

15- Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics): Convenience; Fun/Entertainment; Quality of presentation; Novelty; Other.

Regarding question 15, and given that this question gave the respondents the chance to choose more than one answer, the most frequent answer is revealing of a clear preference. In this case, 66% of the respondents answered that convenience would lead them to use VR in a real estate context, further confirming what previous questions had indicated: that convenience is one of the main reasons that causes the consumer to be interested in this technology.

For reference, the second most chosen option was Quality of presentation, with 43% of the respondents choosing it. Comparing it to the convenience factor, it represents a big disparity, possibly indicating that outside of convenience, the other factors may be secondary to the consumer.

Somewhat surprisingly, only 46 of the 229 (20%) individuals chose Novelty as a factor that would lead them to use the technology, even though in previous questions the novelty factor was indicated to be enticing to the respondents.

Meanwhile, 31% chose Fun/entertainment as an important factor in this regard, which aligns with questions 12 and 13 where the Fun factor was agreed upon as sparking positive feelings on the respondents.

16- When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics): Convenience; Presentation; Time consumption; Informative; Personalized experience; Physical presence; Relationship with agent/company.

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This question relates more specifically with the desires of the consumer overall, not just regarding the use of technology. As such, it is interesting to associate the general wishes of the buyer with the goals asked in previous questions.

For example, as with question 15, it is verified once again that more than 50% of the respondents choose Convenience, exactly 55% in this case. The numbers may seem closer when put in absolute values: 125 chose convenience in question 16 and 151 chose convenience in question 15. Once again, this is the highest frequency of choice, indicating once more that convenience is clearly an essential motivator for the consumer, in general.

The relatively low percentage of respondents that chose physical presence may also be a sign indicating towards a better acceptance of VR in real estate, as only 57 respondents (25%) out of the 229 gave importance to physical presence among the three possible choices they could answer.

Inversely, a high importance is attributed to the informative aspect of the process, with the survey showing that nearly 50% of the respondents believe that the whole process of searching for a house should value the informative aspect, something that can possibly be associated with VR due to the importance that the technology gives to details of the property.

On the other hand, time consumption proved not to be that big of a factor for most respondents. Since one of the appeals of VR is the time it may save for all parties involved in a real estate sale, it is curious to witness that only 35% chose this factor as being important, indicating that perhaps there is more willingness to go through the process more extensively. Similarly, respondents did not seem to value a personalized experience that much, as only 29% chose this characteristic. This may have some ties with the last parameter, which is the relationship with the brand/agent, as this proved to not be valued by the respondents, with only 27 of the 229 (12%) individuals choosing it. The importance of this relationship is mainly relevant to the next hypothesis.

Hypothesis 4- The consumer creates a connection with the company resulting of the interactivity and experience from the use of VR.

For Hypothesis 4, questions 14 and 16 have the most relevancy. This hypothesis aims to see what is the perspective and importance that the respondents give to the brand/company in the real estate context.

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14- In this situation, what would you feel relating to the company? Please answer on a scale from 1 (Strongly disagree) to 6 (Strongly agree): Distance; Trust; Valued (by the company); Motivation; Other.

When asked about the agreement with the sentiment relating to the brand/company, a somewhat significant percentage of the respondents agreed with feeling distance, with almost 50% agreeing on this (46%, to be precise). Although it should be noted that 78 individuals (34%) somewhat disagreed with the statement, with the average answer being 3,47, which translates to somewhat disagreeing.

Conversely, there was much more agreement when asked if the respondents felt trust towards the company, with an overwhelming 141 individuals somewhat agreeing, representing 62% of the total sample. This may indicate some accepting feelings towards real estate agencies that choose to use VR. In this factor, only 1 individual strongly disagreed with this notion of trust.

Similar to the previous factor, only 1 respondent strongly disagreed that he would feel valued by a company that used VR in the process of looking for houses. 59% of the sample somewhat agreed that they would feel valued, which is the average answer (mean of 4,1).

The same trend continues with the motivation factor, as 130 (57%) respondents somewhat agreed that they would feel motivated to use the company in this situation, thus confirming the indicators shown previously that a technology like this would be enticing to the customer.

Lastly, when it comes to the “Other” category, some notable answers had some repetition, and thus should be referenced. For example, 4 individuals wrote that they would find the company to be innovative in this case, 3 respondents wrote that they would find it fun and 2 other respondents stated they would find the company to be appealing in this situation.

16- When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics): Convenience; Presentation; Time consumption; Informative; Personalized experience; Physical presence; Relationship with agent/company.

Even though this question was analyzed previously, it is relevant to emphasize the category referring to the relationship with the agent/company. As seen before, this is not a factor of much relevance to the 229 respondents, as only 12% of them chose it as an important characteristic when looking to buy a house. Taking the answers to the previous question in consideration, this

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relationship can possibly be fostered with the use of VR, which seems to appeal to individuals and entice them to choose the company over others.

Survey Overview

After analyzing the data gathered by the survey, some key takeaways will be summarized in this chapter, solely pertaining to the survey. It is clear initially that a wide majority of the respondents already knew Virtual Reality before answering the survey. On the other hand, only slightly more than half the sample had used it before, in any context. The young nature of the technology may play a role in this fact, as it was shown to be seen as innovative by the respondents. Throughout the survey, the respondents consistently showed mainly positive feeling towards the technology, repeatedly finding it to be convenient and easy to use, specifically in the real estate context, which may suggest some widespread acceptance.

Lastly, even though most of the sample did not give great importance to the relationship between the brand using VR and the customer, the survey indicates clearly that the sample responds very well to companies using VR in the process of searching for houses.

3.5 The Interviews

To understand the present and future impact of Virtual Reality to real estate workers, interviews were conducted. Due to the open manner in which interviews are typically conducted and answered, no pre-test was needed to gather this secondary data.

The interviews were conducted by cellphone call, after each interviewee accepted to give the interview and provided their cellphone number.

The interviews were designed with the purpose of obtaining diverse answers and points of view. A script was followed in these interviews, albeit very loosely, as the goal was to obtain a full scope of the interviewees' and not restrict them on what they intended to share. Sometimes, certain questions of the script were not asked because the interviewee had already given plenty of information about said question in a previous answer, thus fulfilling the goal of the research, which is to obtain the most information possible. The script utilized for the interviews is available in Appendix 3.

3.5.1 The Interview sample

The sample, in this data collection procedure, was of two real estate workers. It is noteworthy to reference that the relative youth of the technology's implementation acted as a limitation in this procedure, as there simply were not a lot of professionals familiarized with the technology

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that could be contacted. The two interviewees were male, with the ages of 34 and 37, respectively.

3.5.2 The Interview results

Interviews Overview

The interviews provided two different perspectives, undoubtedly, but both perspectives are interesting and informative to analyze the effect of Virtual Reality through the optics of the business. The first difference is that the first interviewee, André, claimed to try implementing VR through a startup company, with unnamed technology. Hélder, the second interviewee, employs the Matterport system in his company, which is the most popular VR technology in real estate. While André states that his company experimented with the technology before fully implementing, Hélder's company has been using it for years. André's business ultimately did not fully implement VR due to the lack of cost effectiveness. André revealed not to have a great opinion of the technology in the state that it is right now, mainly due to its costs and it not being differentiating enough to be worth it, in his opinion. In André's perspective, customers might even prefer to have a more personal experience, and the real estate agent may benefit more from having personal contact with the customer throughout the process, for branding purposes. Despite this, the conclusion seems to be that he wants to give VR another chance when it becomes more accessible in terms of price.

As for Hélder, his opinion differs from André's, as he believes that VR is worth it even if it is slightly costly, as the prices may vary according to the property it is being used in. From his perspective, the time it saves to all parties and the type of costumers it attracts is worth the investment, especially for higher-end properties. Hélder does appear to agree with André in the sense that both would prefer the technology to be cheaper than it is right now, but Hélder is adamant that VR is the future of real estate and should become a widespread practice in the future.

In conclusion, both professionals have opposite types of experience with VR, but the consensus seems to be that using the technology is not financially efficient in most properties at this point in time.

4. Conclusion

The final chapter of this research is dedicated to presenting the conclusions gathered from the survey data analysis and the interviews, in order to answer the two research questions and discuss about the main takeaways from the project.

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This research has the main goal of understanding the impact that Virtual Reality has in the real estate sector, as well as the impact it could have. The goal is to understand this impact from the perspective of the consumer and simultaneously from the business perspective. To assess the impact that this technology can have on consumers, the hypothesis developed were geared towards the technology itself, the behavior of the consumer and the relationship that the brand/real estate company develops with the consumer, although the latest factor can also be considered to be relevant to the business side of the analysis. Following this, a survey was elaborated and distributed exclusively to the consumer, to obtain their perspective. From this survey the intention was to assess the level of knowledge and familiarity that the consumer has with the technology, how its innovation is seen by the consumer, the perceived benefits of VR, the comfort and convenience of it, the practical utility it can have and finally the feelings the technology spark in the consumer.

The results from the survey, presented at length in the previous section, lead to the following conclusions, all in hopes of answering the first research question: consumers have knowledge about VR, but not practical use with the technology. The novelty factor may have influenced this fact. Following this, the respondents in general showed positive feelings towards the interactivity of Virtual Reality, in two distinct scenarios that were presented, being that one of the scenarios was real estate related. In both scenarios, the technology was found to be fun, convenient, appealing and even informative. Finally, the technology was found to elicit positive feeling from the consumer towards the brand/company using it, as a significant percentage of the respondents demonstrated feeling more valued by the company and motivated to use it.

Individually, the first hypothesis, **“The novelty and innovation aspect of VR triggers the consumer’s attention”**, is confirmed by the high amount of respondents that agreed with the sentiment of wanting to know more about the technology due to its recent upsurge, around 88,6%. The second hypothesis, that states that **“ The consumer responds favorably to the interactivity of VR”** is corroborated by the satisfaction of the experience presented by the respondents with previous use of VR, the notion that the technology is easy to use, and the perception of it being appealing and fun to use. The third hypothesis, **“The use of VR is more convenient and comfortable for the consumer”**, is confirmed by the elevated percentage of respondents that described VR as being convenient in multiple instances, both in a real estate context or otherwise. Finally, the fourth hypothesis, stating that **“The consumer creates a connection with the company resulting of the interactivity and experience from the use of VR”** is also confirmed by the data that demonstrates the feeling of being valued by the

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company, among other positive feelings that a hypothetical company using VR elicits in the consumer.

Overall, the clear positive indicators answer the first research question from the survey. The analysis shows that VR is indeed an appealing alternative to the consumer, as most of the consumers in this research find the technology to be convenient, appealing, fun to use, and easy to pick up, even in a real estate context.

Regarding the interviews, with the goal of answering the second research question about the effectiveness of VR to the company using it, the conclusion seems to be that it is not financially effective as of now to employ VR as a main tool to lure customers. Both interviewees demonstrated concern over the current costs of implementing it, and the interviewee that showed a more optimistic opinion and experience with VR stated that, as of now, it is mainly worth it for real estate properties that involve bigger investments. There is some emphasis in noting that, commonly, the investment of setting up a VR tour for a specific property is dependent on the individual real estate agent regarding costs of the technology, and the return on investment on the specific property is only collected when the property is sold, meaning that it could take an extended time for the agent to recover his investment. According to one of the interviewees, this is one of the main drawbacks that the implementation of VR faces in the industry. This means that, even through the eyes of someone who is a supporter of the widespread implementation of VR, the idea that it could be used daily for any “common” property is still not present. In summary, the second research question is answered by both interviews, leaving the clear idea that, at this moment, Virtual Reality is not financially effective in the real estate business, due to its high costs and uncertain return on investment.

In general, this research shows that the consumer is ready to involve VR in its buying process willingly, given the already positive impression they have of it. From this perspective, VR is an interesting and appealing option to include in the buying process, whether it be in general terms or, in this case, to buy a house. The interviews explained that a buyer that uses VR in the process usually uses it to complement physical visits, thus saving time and not having to visit every property in person. This convenience and efficiency to the consumer is certainly the main draws to convince the general consumer to embrace VR. This is one of the biggest benefits of VR in real estate and it is yet to be explored in a wider manner throughout the whole industry, which is what this research suggests should happen.

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4.1. Limitations of the research

As with every research, this study is not without its limitations. This section is dedicated to highlighting the shortcomings of this present research.

The most obvious limitation is the fact that VR is a very recent technology and it is not widely used in many sectors. Being that it is a tool with approximately only a decade of real practical use in developed industries, there is not much theoretical information to gather, or data from use cases to analyze.

Another shortcoming is that 229 respondents on the survey cannot be seen as a representative sample of the whole country, thus not being significant in understanding the perception of the general population.

Besides this, the survey was solely shared online, meaning that only individuals with internet were able to answer it. This means that a big portion of the population would not be able to answer the survey in any way.

To add to this factor, the age of the people who are more likely to answer surveys on social media may not be similar to the age of the people who generally look for houses to buy or rent, in the specific case of Portugal. Even though the study is designed to know the opinions of individuals who may do it in the future, their lack of past experience in the subject may skew the overall opinion in the matter.

Regarding the interviews, the biggest limitation is related to the lack of implementation that VR has in the country, meaning that it is extremely rare and difficult to encounter true experts in the field. This leads to lopsided information, as there isn't a big sample of use and duration of use with the technology, which in turn leads to imperfect conclusions regarding the real impact that VR can have in the sector.

4.2. Future Research

Due to the young life of this technology that only exists in its current conception since the early 2010's although it was conceptualized in a much different form in the 1960's, it is clear that more research is needed on the subject, especially regarding industries like real estate.

This research may be a good indicator that further analysis about the usefulness of VR to the consumer is needed. At the moment, there is little literature about the topic in the context of real estate, and it would certainly be interesting to have more data on the subject. Furthermore,

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it would be interesting to understand more about the consumer’s perspective when it comes to using this type of technology in any real estate related transaction.

In addition, this research may be a good starting point to analyzing how efficient using VR can be to agents and customers alike, in terms of time and money. At this time it is difficult to estimate how much money can be saved by having virtual tours, as the implementation costs have variations and are still too young to be tracked down effectively, and it would be interesting for any future research to analyze this with more depth. The same can be said for the time effect of VR in the industry, as the survey suggest that it would be more convenient to the customer to use VR, and future research could further study if this perceived convenience is synonym with saving time.

Overall, further research will surely benefit from the technology being older and more developed, and it will certainly obtain more concrete answers about the real use and impact of VR in the sector.

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6. Appendices

Appendix 1

Virtual Reality acceptance

Start of Block: Block 1

Q1 This survey contains questions about Virtual Reality and its impact on the consumer. It was developed by a Catolica's master student for a Dissertation Thesis. Completing this questionnaire takes about 5 minutes. Please remember that there are no wrong answers, I am interested in your behavior and opinions. Data will be treated confidentially. Thank you for your time

In case you have any question/doubt feel free to contact us: 152118343@alunos.lisboa.ucp.pt

Page Break

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End of Block: Block 1

Start of Block: Socio demographic

Q2 In this section I'll ask some questions about you (remember, it's anonymous)

Q3 Gender

- Male (1)
 - Female (2)
-

Q4 What is your age?

- 18-24 (1)
 - 25-34 (2)
 - 35-44 (3)
 - 45-54 (4)
 - More than 54 (5)
-

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Q5 Number of children

- 0 (1)
 - 1 (2)
 - 2 (3)
 - 3 (4)
 - 4 (5)
 - 5 or more (6)
-

Q6 What's the highest degree or level of school you have completed? If currently enrolled, highest degree received?

- High school degree (1)
 - Bachelor's degree (2)
 - Masters degree (3)
 - Doctorate degree (4)
 - Other (5)
-

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Q7 What is your current employment status?

- Employed (1)
- Self-employed (2)
- Unemployed and looking (3)
- Unemployed and not looking (4)
- Student (5)
- Retired (6)

End of Block: Socio demographic

Start of Block: Block 3

Q8 Virtual Reality is a simulated experience that aims to virtually recreate the real world or an imagined one, and this can be done through a virtual reality headset or a multi-projected environment without a headset (think detailed presentation on your smartphone). In this section I'll ask about your opinion on the technology.

Page Break

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Q9 Have you ever heard about Virtual Reality technology?

Yes (1)

No (2)

Q10 Have you ever used Virtual Reality?

Yes (1)

No (2)

Q11 If you have used Virtual Reality before, please specify in which situation:

Gaming (1)

Real estate (2)

Retail shopping (3)

Interior design (4)

Teaching/learning (5)

Other (6) _____

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Q12 If you have previously tried Virtual reality, please indicate on a scale from 1 to 6 what was the degree of satisfaction obtained from your experience. If not, ignore this question:

- Very unsatisfied (1)
- Unsatisfied (2)
- Somewhat unsatisfied (3)
- Somewhat satisfied (4)
- Satisfied (5)
- Very satisfied (6)

End of Block: Block 3

Start of Block: Block 4

Q13 Volvo, a car manufacturer, implemented the virtual test drive for their xc90 model using VR, giving the chance of experiencing the vehicle and drive it around without the customer having to leave their house. This virtual test drive consists of downloading a free app, and this app can be used with Google Cardboard (low-cost VR headset that can be paired with any smartphone) or without the headset.

Page Break

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Q14 Please classify the following statement on a scale from 1 (strongly disagree) to 6 (strongly agree): With the popularization of this technology, the innovation and novelty of it makes me want to learn about it and use it.

- Strongly disagree (1)
 - Disagree (2)
 - Somewhat disagree (3)
 - Somewhat agree (4)
 - Agree (5)
 - Strongly agree (6)
-

Q15 Indicate the degree of difficulty which you associate with using this technology, on a scale of 1 (Very hard) to 6 (Very easy)

- Very hard (1)
- Hard (2)
- Slightly hard (3)
- Slightly easy (4)
- Easy (5)
- Very easy (6)

End of Block: Block 4

Start of Block: Real estate

Q16 Sotheby's International Realty is a real estate agency that has Virtual Tours where you can use a VR headset for your iPhone or Android mobile phone (bought separately, can cost between 14\$ and

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99\$) to tour any house in their website to explore the home in detail. Imagine that you were a client using Sotheby’s website and VR to at houses to buy.

Page Break

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Q17 On a scale from 1 (strongly disagree) to 6 (strongly agree), classify how you would find the interaction of making a Virtual Reality tour in a house before buying it:

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Convenient (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Attractive (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Informative (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fun (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Insignificant (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q18 After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting? Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree).

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Uninteresting (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unrealistic (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Useful (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fun (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Appealing (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Difficult to use (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Q19 In this situation, what would you feel relating to the company? Please answer on a scale from 1 (strongly disagree) to 6 (strongly agree).

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Distance (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Trust (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Valued (by the company) (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Motivation (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q20 Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics)

- Convenience (1)
 - Fun/entertainment (2)
 - Quality of presentation (3)
 - Novelty (4)
 - Other (5) _____
-

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Q21 When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics)

- Convenience (1)
 - Presentation (2)
 - Time consumption (3)
 - Informative (4)
 - Personalized experience (5)
 - Physical presence (6)
 - Relationship with agent/company (7)
-

Q22 Would you buy a Virtual Reality setup if you could?

- Yes (1)
 - No (2)
-

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Q23 Please classify this statement on a scale of 1 (strongly disagree) to 6 (strongly agree): **The utilization of this technology can be a key element for future real-estate purchases.**

- Strongly disagree (1)
- Disagree (2)
- Somewhat disagree (3)
- Somewhat agree (4)
- Agree (5)
- Strongly agree (6)

Appendix 2

SPSS descriptive statistics

Table 1

		Gender			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	143	62,4	62,4	62,4
	Female	86	37,6	37,6	100,0
	Total	229	100,0	100,0	

Table 2

		What is your age?			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	136	59,4	59,4	59,4
	25-34	84	36,7	36,7	96,1
	35-44	7	3,1	3,1	99,1
	45-54	2	,9	,9	100,0
	Total	229	100,0	100,0	

SPSS descriptive statistics- Hypothesis 1

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Table 3

Have you ever heard about Virtual Reality technology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	218	95,2	95,2	95,2
	No	11	4,8	4,8	100,0
	Total	229	100,0	100,0	

Table 4

Please classify the following statement on a scale from 1 (strongly disagree) to 6 (strongly agree): With the popularization of this technology, the innovation and novelty of it makes me want to learn about it and use it.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	9	3,9	3,9	4,4
	Somewhat disagree	16	7,0	7,0	11,4
	Somewhat agree	74	32,3	32,3	43,7
	Agree	110	48,0	48,0	91,7
	Strongly agree	19	8,3	8,3	100,0
	Total	229	100,0	100,0	

SPSS descriptive statistics- Hypothesis 2

Table 5

Indicate the degree of difficulty which you associate with using this technology, on a scale of 1 (Very hard) to 6 (Very easy)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very hard	2	,9	,9	,9
	Hard	13	5,7	5,7	6,6
	Slightly hard	44	19,2	19,2	25,8
	Slightly easy	72	31,4	31,4	57,2
	Easy	76	33,2	33,2	90,4
	Very easy	22	9,6	9,6	100,0
	Total	229	100,0	100,0	

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Table 6

**If you have previously tried Virtual reality,
please indicate on a scale from 1 to 6 what was the degree of satisfaction
obtained from your experience. If not, ignore this question:**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very unsatisfied	4	1,7	3,1	3,1
	Unsatisfied	1	,4	,8	3,9
	Somewhat unsatisfied	5	2,2	3,9	7,8
	Somewhat satisfied	40	17,5	31,3	39,1
	Satisfied	59	25,8	46,1	85,2
	Very satisfied	19	8,3	14,8	100,0
	Total	128	55,9	100,0	
Missing	System	101	44,1		
Total		229	100,0		

Table 7

**On a scale from 1 (strongly disagree) to 6(strongly agree), classify how
you would find the interaction of making a Virtual Reality tour in a
house before buying it: - Convenient**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	8	3,5	3,5	3,9
	Somewhat disagree	14	6,1	6,1	10,0
	Somewhat agree	60	26,2	26,2	36,2
	Agree	98	42,8	42,8	79,0
	Strongly agree	48	21,0	21,0	100,0
	Total	229	100,0	100,0	

Table 8

**On a scale from 1 (strongly disagree) to 6(strongly agree), classify how
you would find the interaction of making a Virtual Reality tour in a
house before buying it: - Attractive**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	9	3,9	3,9	4,4
	Somewhat disagree	26	11,4	11,4	15,7
	Somewhat agree	83	36,2	36,2	52,0
	Agree	81	35,4	35,4	87,3

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Strongly agree	29	12,7	12,7	100,0
Total	229	100,0	100,0	

Table 9

On a scale from 1 (strongly disagree) to 6(strongly agree), classify how you would find the interaction of making a Virtual Reality tour in a house before buying it: - Informative

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	,9	,9	,9
	Disagree	6	2,6	2,6	3,5
	Somewhat disagree	36	15,7	15,7	19,2
	Somewhat agree	74	32,3	32,3	51,5
	Agree	87	38,0	38,0	89,5
	Strongly agree	24	10,5	10,5	100,0
	Total	229	100,0	100,0	

Table 10

On a scale from 1 (strongly disagree) to 6(strongly agree), classify how you would find the interaction of making a Virtual Reality tour in a house before buying it: - Fun

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	1,3	1,3	1,3
	Disagree	6	2,6	2,6	3,9
	Somewhat disagree	20	8,7	8,7	12,7
	Somewhat agree	66	28,8	28,8	41,5
	Agree	74	32,3	32,3	73,8
	Strongly agree	60	26,2	26,2	100,0
	Total	229	100,0	100,0	

Table 11

On a scale from 1 (strongly disagree) to 6(strongly agree), classify how you would find the interaction of making a Virtual Reality tour in a house before buying it: - Insignificant

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	41	17,9	17,9	17,9
	Disagree	83	36,2	36,2	54,1
	Somewhat disagree	60	26,2	26,2	80,3
	Somewhat agree	31	13,5	13,5	93,9

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Agree	13	5,7	5,7	99,6
Strongly agree	1	,4	,4	100,0
Total	229	100,0	100,0	

Table 12

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Uninteresting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	29	12,7	12,7	12,7
	Disagree	68	29,7	29,7	42,4
	Somewhat disagree	76	33,2	33,2	75,5
	Somewhat agree	31	13,5	13,5	89,1
	Agree	16	7,0	7,0	96,1
	Strongly agree	9	3,9	3,9	100,0
	Total	229	100,0	100,0	

Table 13

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Unrealistic

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	17	7,4	7,4	7,4
	Disagree	84	36,7	36,7	44,1
	Somewhat disagree	66	28,8	28,8	72,9
	Somewhat agree	45	19,7	19,7	92,6
	Agree	14	6,1	6,1	98,7
	Strongly agree	3	1,3	1,3	100,0
	Total	229	100,0	100,0	

Table 14

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Useful

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		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	5	2,2	2,2	2,6
	Somewhat disagree	13	5,7	5,7	8,3
	Somewhat agree	86	37,6	37,6	45,9
	Agree	102	44,5	44,5	90,4
	Strongly agree	22	9,6	9,6	100,0
	Total	229	100,0	100,0	

Table 15

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Fun

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	1,7	1,7	1,7
	Somewhat disagree	15	6,6	6,6	8,3
	Somewhat agree	88	38,4	38,4	46,7
	Agree	79	34,5	34,5	81,2
	Strongly agree	43	18,8	18,8	100,0
	Total	229	100,0	100,0	

Table 16

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Appealing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	8	3,5	3,5	3,9
	Somewhat disagree	15	6,6	6,6	10,5
	Somewhat agree	94	41,0	41,0	51,5
	Agree	77	33,6	33,6	85,2
	Strongly agree	34	14,8	14,8	100,0
	Total	229	100,0	100,0	

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Table 17

After reading Sotheby’s example, what do you feel about the virtual interaction/involvement of VR relating to house hunting?

Please answer this question on a scale from 1 (strongly disagree) to 6 (strongly agree). - Difficult to use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	10	4,4	4,4	4,4
	Disagree	62	27,1	27,1	31,4
	Somewhat disagree	93	40,6	40,6	72,1
	Somewhat agree	52	22,7	22,7	94,8
	Agree	10	4,4	4,4	99,1
	Strongly agree	2	,9	,9	100,0
	Total	229	100,0	100,0	

SPSS descriptive statistics- Hypothesis 3

Table 18

Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics):

	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics) - Selected	151	65,9%	78	34,1%	229	100,0%
Choice Convenience *						
Gender						

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Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics) - Selected Choice Fun/entertainment * Gender	72	31,4%	157	68,6%	229	100,0%
Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics) - Selected Choice Quality of presentation * Gender	99	43,2%	130	56,8%	229	100,0%
Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics) - Selected Choice Novelty * Gender	46	20,1%	183	79,9%	229	100,0%
Which of these characteristics would lead you to use the aforementioned technology in searching for a house to buy? (Please choose a maximum of three characteristics) - Selected Choice Other * Gender	25	10,9%	204	89,1%	229	100,0%

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Table 19

When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics):

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Convenience * Gender	125	54,6%	104	45,4%	229	100,0%
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Presentation * Gender	78	34,1%	151	65,9%	229	100,0%
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Time consumption * Gender	80	34,9%	149	65,1%	229	100,0%
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Informative * Gender	114	49,8%	115	50,2%	229	100,0%

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When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Personalized experience * Gender	66	28,8%	163	71,2%	229	100,0%
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Physical presence * Gender	57	24,9%	172	75,1%	229	100,0%
When searching for a house to buy, what are the characteristics that you deem more important in the process? (Please choose a maximum of three characteristics) Relationship with agent/company * Gender	27	11,8%	202	88,2%	229	100,0%

SPSS descriptive statistics- Hypothesis 4

Table 20

In this situation, what would you feel relating to the company? Please answer on a scale from 1 (strongly disagree) to 6 (strongly agree). -

Distance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	4	1,7	1,7	1,7
	Disagree	42	18,3	18,3	20,1
	Somewhat disagree	78	34,1	34,1	54,1
	Somewhat agree	59	25,8	25,8	79,9
	Agree	40	17,5	17,5	97,4
	Strongly agree	6	2,6	2,6	100,0
	Total	229	100,0	100,0	

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Table 21

In this situation, what would you feel relating to the company? Please answer on a scale from 1 (strongly disagree) to 6 (strongly agree). - Trust

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	14	6,1	6,1	6,6
	Somewhat disagree	31	13,5	13,5	20,1
	Somewhat agree	141	61,6	61,6	81,7
	Agree	40	17,5	17,5	99,1
	Strongly agree	2	,9	,9	100,0
	Total	229	100,0	100,0	

Table 22

In this situation, what would you feel relating to the company? Please answer on a scale from 1 (strongly disagree) to 6 (strongly agree). - Valued (by the company)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	,4	,4	,4
	Disagree	6	2,6	2,6	3,1
	Somewhat disagree	28	12,2	12,2	15,3
	Somewhat agree	134	58,5	58,5	73,8
	Agree	54	23,6	23,6	97,4
	Strongly agree	6	2,6	2,6	100,0
	Total	229	100,0	100,0	

Table 23

In this situation, what would you feel relating to the company? Please answer on a scale from 1 (strongly disagree) to 6 (strongly agree). - Motivation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	8	3,5	3,5	3,5
	Somewhat disagree	22	9,6	9,6	13,1
	Somewhat agree	130	56,8	56,8	69,9
	Agree	54	23,6	23,6	93,4
	Strongly agree	15	6,6	6,6	100,0
Total	229	100,0	100,0		

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SPSS chart- Hypothesis 1

Chart 2

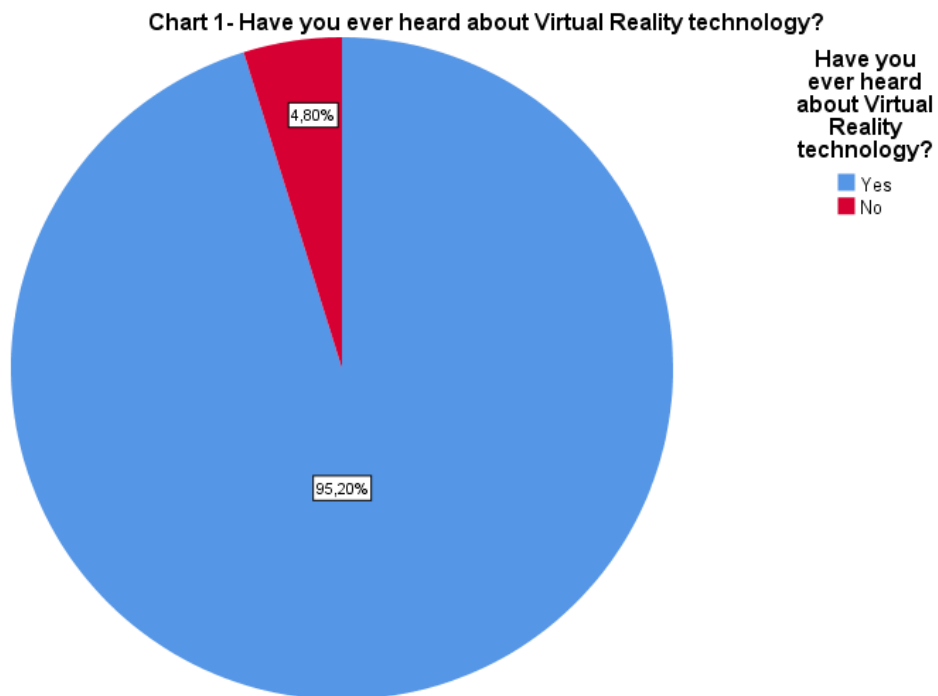
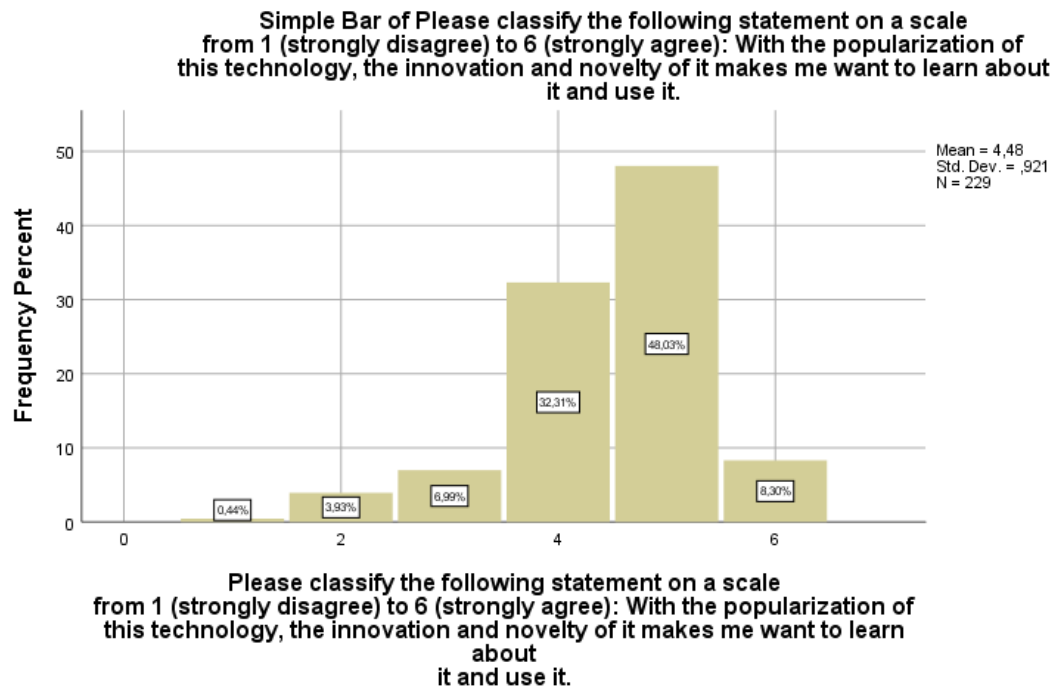


Chart 3

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Appendix 3

Interview script

- 1- What is your name, age and profession?
- 2- How long have you worked in the real-estate industry?
- 3- Have you ever used virtual reality technology in your profession? If yes, in what way did this technology benefit the job?
- 4- Why did you decide to implement this technology?
- 5- If any, what are the advantages and disadvantages of employing this technology in a sale?
- 6- Can you give me information about the financial cost of having this technology in your firm?
- 7- Is the demand high for the use of this technology in house hunting?
- 8- Do you believe that virtual reality technology impacts the customer's final decision on buying the house?
- 9- Do you believe that the advantages of this technology are worth its implementation costs?
- 10- Do you think it makes sense to use this technology nowadays and in the future?
- 11- What are the firms objectives in the long and short run regarding VR use?

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Appendix 4

Interview 1

Question 1- My name is André Maia, I'm 34 years old and I work as a real estate consultant

Question 2- I have been in the real estate industry for approximately 7 or 8 years.

Question 3- Yes, I have used it before, around 2 or 3 years ago. At the time we tested the technology with a start-up company, they provided the software and headset. It cost around 50 euros per property. It was a relatively small test-run, and it wasn't satisfying enough to become standard use in the company.

Question 4- At the time the technology sounded interesting and innovating, but we chose to not implement it widely after testing it, mainly because we did not think it was accessible enough. For example, a VR tour could not be exposed in many websites because the websites did not have specific support for it, as the VR uses its own platform.

Question 5- For advantages, the main ones are the differentiation factor, as it adds another layer of differentiation to the company. Adding to that, there is the advantage to the buyer that they can visit a house without having to be physically present, and for the real estate agent, the technology is time-saving and avoids physical presence, but this is something that video-tours already do. For disadvantages, the main one is the cost, as in my opinion it's not worth it. The cost implies that the agent has to travel to the house to make scans of the property with their own cameras and on their own time, and the price that we paid per property to have access to the technology was 200 euros per house. Furthermore, a video or a personal tour can be a personalized experience and a marketing tool for the agent at the same time, leaving VR at a disadvantage. Video tours are more practical, because in this case we only film the highlights of the house the client wants to see, and with VR the client has to see the whole house and he may not be interested in seeing every part, making VR redundant and less efficient than video tours. It should be noted that in this case, using VR does not add or subtract intermediaries: the number of people involved in the sale process is the same regardless.

Question 6- Yes, the prices we had to pay to the startup company that was going to partner with us were of 100/200 euros for the headset and 400/500 euros for the software.

Question 7- Even if we did not implement VR widely, I believe I can say it has impact in the final decision, when used. However, I would not say that it's the most impacting factor, as there are other much more important requirements for a client. Ultimately, I would say that it is not

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part of the Portuguese culture to embrace this type of technologies. Someone who wants to buy their dream house in Portugal won't make their decision based solely in a VR tour.

Question 8- The demand is not really direct. There are clients that ask for a more personalized experience, and in those cases, the VR is used, but it is not very common. The demand is indirect because we guide the clients to use the technology after they ask for a different experience.

Question 9- At the moment, no. That is the main reason why we did not implement it widely. A simple video tour is cheaper, employs a dedicated team of videographers to do it and does not take away the agent's time. Furthermore, very few platforms support VR right now, so a property put on sale using VR will not have the same visibility to the public as all the others.

Question 10- I do believe it will be an important tool in the future, but only after it evolves and changes in various ways. Right now, it's simply not efficient. In our experience, it doesn't subtract middlemen in the selling process, and it's not accessible due to lack of adoption in the sector as a whole, in Portugal.

Question 11- We are monitoring the advances of the technology, so when inevitably the costs of it go down and it becomes more efficient to implement it, we can try to invest in it again.

Interview 2

Question 1- My name is Hélder Pereira, I'm 37 years old and I'm Commercial Director at Zome, in Porto. I used to be a real estate consultant, for 4 years.

Question 2- I was a consultant for 4 years, and have been a Director for a year and a half. Therefore, in total, I've been in the industry for almost 6 years.

Question 3- At Zome, I also am in charge of the technology department overall. When I was a consultant, I had contact with multiple companies that offered VR technology, in order to bring it to Zome. All of the companies used different methods, and I analyzed them and that was my first contact with the technology. After some time, the Matterport technology became more popular and it's the technology that we believe to be the best with VR. At the time, in 2017, what was needed for this system was a special camera that filmed 360 degrees of every room in detail, and a third party company that would compile the pictures taken by the camera, for a certain price. Nowadays, since the Matterport camera is more commercial, individual photographers acquire it and sell their service of doing the scan to real estate firms. But in practice, every real estate agent can do this on his own, there is no real necessity of hiring a photographer.

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Question 4- The technology, as it stands, is only implemented in certain houses or properties. We only typically use VR in the most expensive properties, because the technology in itself is still expensive. The main goal was for the visiting process to be less time consuming for the customer. Since we have many clients that are interested in the top of the line properties, but don't have much free time, we figured the implementation made sense. We do not use a headset, the virtual tour can be seen on the computer or a smartphone.

Question 5- The main advantage is clearly the timesaving aspect. We've had clients that have an extremely busy schedule and have to be extra selective with the houses they visit. In this case, they usually visit multiple houses with VR, and then narrow their choices to the select few they want to visit physically. We also have foreign investors that don't want to travel just to visit a potential acquisition, they need a higher degree of certainty. These are the type of clients that benefit from VR the most. When it comes to disadvantages, the main one is the expensiveness of the technology. Furthermore, the agent often goes through the trouble of setting up a property for a VR scan out of his own pocket, and this might not be rewarding since a real estate agent only receives his payment after. Due to the price, it is not worthwhile to use the technology on more common or lower-end properties.

Question 6- The Matterport machine, in 2017, cost around 4000 euros. It may be cheaper now. The online platform where the images were uploaded from the Matterport camera to create the actual tour cost around 20 euros a month.

Question 7- I believe so, because when a client does the VR tour, they usually get their own idea of the house and, in my experience, it builds their interest. The visit is so detailed that the buyer might even spend more time watching every room than normal, and this plays a role in their decision to physically visit the property.

Question 8- Around 25% to 30% of Zome's agents use the technology, and around 90% of our higher-end properties have a virtual tour setup. We can't really estimate if the customer used the virtual tour or not, as the tour is completely online. But in most of our conversations with buyers of high-end properties, we make sure to ask if they used the virtual tour, and a significant part of them respond positively.

Question 9- I think it is worth it, but I would still like it to be less expensive, so it would be more widely adopted. If it were less expensive, it would be worthwhile even for the cheaper properties.

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Question 10- I’m usually very open to technology, so I clearly believe that this technology has an important role in the future of the real estate industry. I believe that in the future the trend will be avoiding physical presence whenever possible, and relying on a computer or smartphone, and this is where I believe that VR will be important. And it’s undeniable that VR saves the consumer and the agent’s time.

Question 11- Right now Zome is emphasizing the virtual tour, and during the pandemic we used it abundantly and only did physical visits to finalize the deal. We want to maintain this in the future, and hopefully make it more common to use for all levels of property price range.